

SRT Status and Plans for Version-7

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NASA GSFC Sounder Research Team (SRT)

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Accomplishments since May 2013 Meeting

Our major accomplishment has been to bring SRT Version-6 up to date with JPL

Some previously unknown differences were found and corrected

SRT Level-2 and Level-3 Version-6 and Version-6 AO results now match JPL

We have also made improvements to the water vapor profile $q(p)$ retrieval step



Short Range SRT Plans for Version-7

Re-optimize details of all retrieval steps

Most optimization previously done used 2 regression start up state

$q(p)$ retrieval had not been modified since Version-4

Version-6 $q(p)$ retrieval degrades Neural-Net guess

We have already made significant improvements in $q(p)$ retrieval methodology in our current SRT Version-6.1

$q(p)$ retrieval now takes tropopause height into consideration

Ozone retrieval step should do the same

Version-6.1 $q(p)$ retrieval performs much better than Version-6

We will further revisit $q(p)$ channels, functions, and damping

We will consider a second pass $q(p)$ retrieval step

Not found useful in Version-5 and never tested in Version-6



Version-6.1 Changes made to Water Retrieval Step

Modified Neural-Net $q^0(p)$ guess above the tropopause

Linearly tapers the neural net guess to match climatology at four fine levels above the tropopause

Changed the 11 trapezoid $q(p)$ perturbation functions used in Version-6 so as to match the 23 functions used in $T(p)$ retrieval step

Increased the damping used in $q(p)$ step because we now have more functions

Results tested on May 30, 2010 data

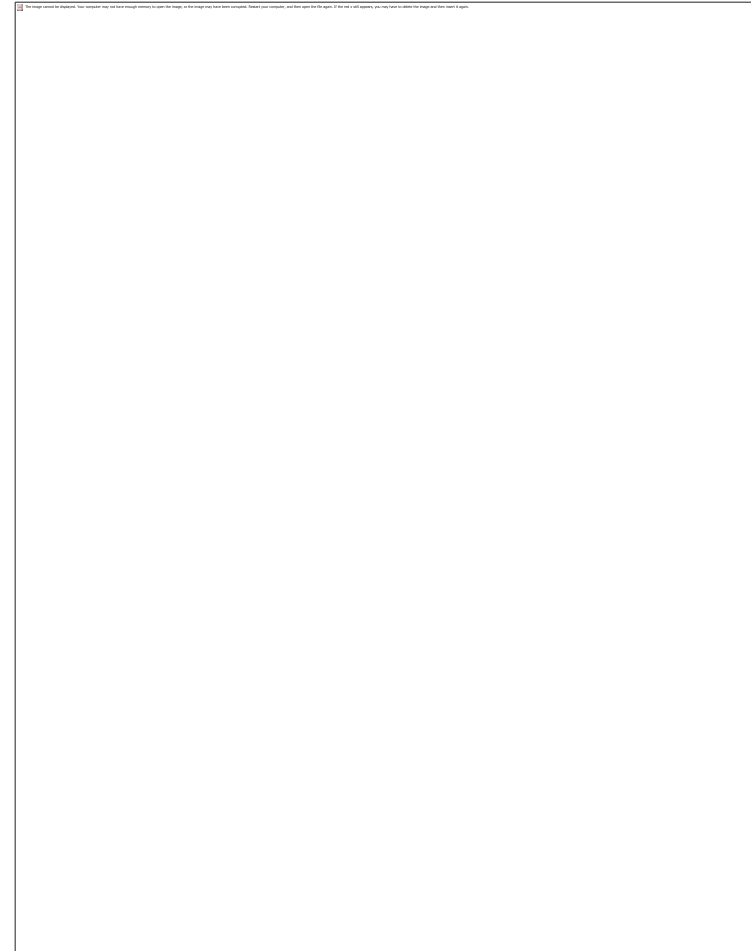
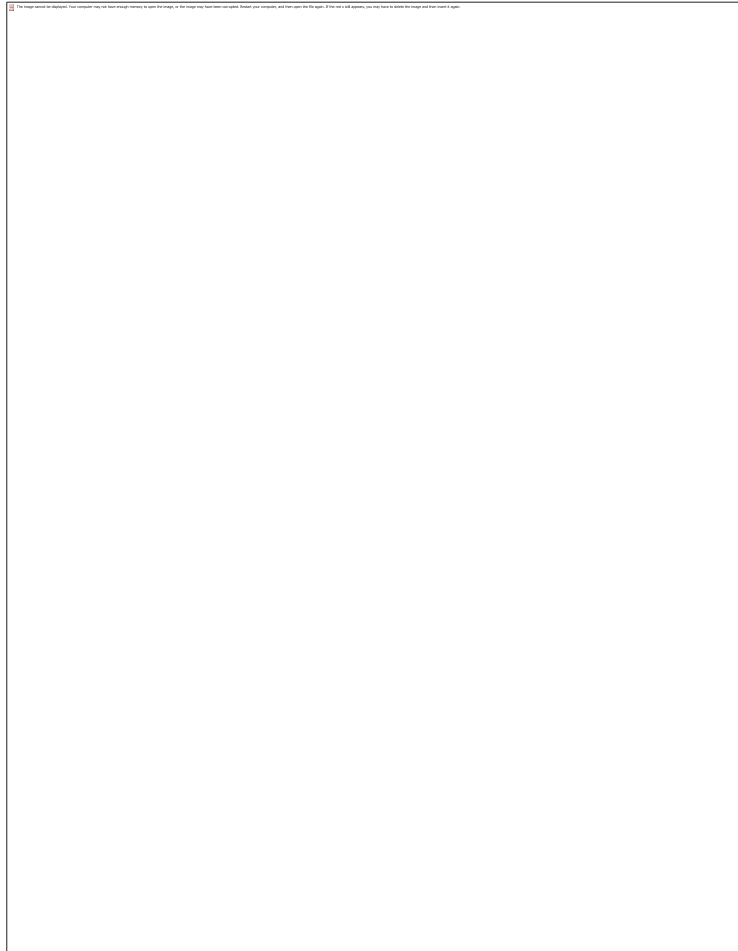


Global Water Vapor May 30, 2010

1 Km Layer

Precipitable Water RMS
% Differences from ECMWF

Percent Yield



- | | | |
|---------|-------------|-------------------------|
| ———— | Version-6 | DA (QC=0; PBest) |
| - - - - | Version-6 | Climate (QC=0,1; PGood) |
| ———— | Version-6.1 | DA (QC=0; PBest) |
| - - - - | Version-6.1 | Climate (QC=0,1; PGood) |

Accuracy with Climate QC has improved considerably over Version-6
Data Assimilation (DA) accuracy has also improved with increased yield

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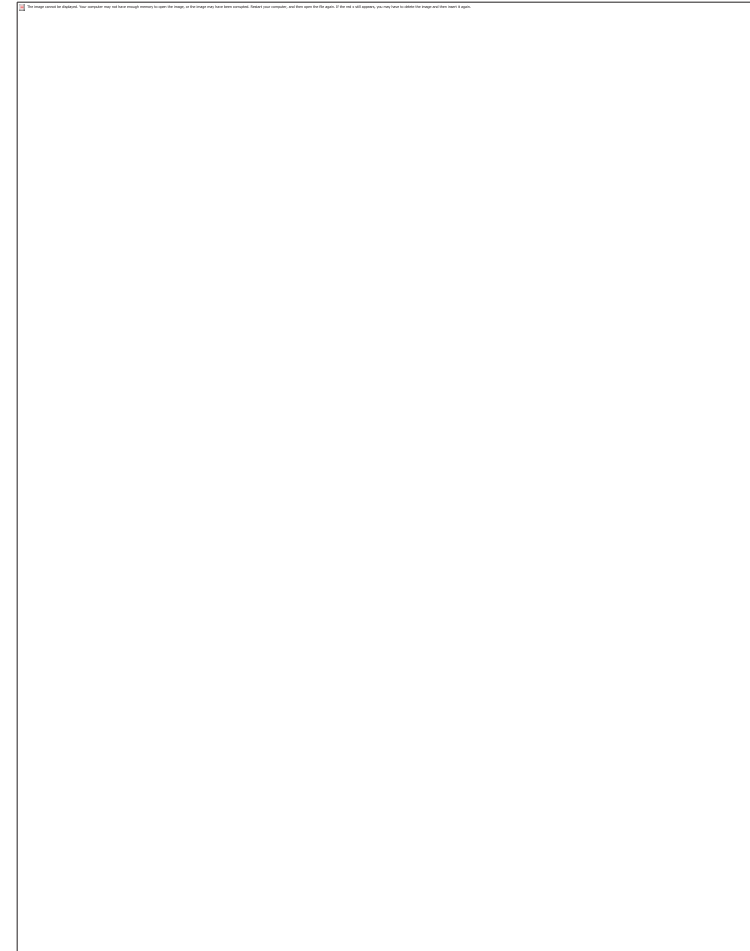
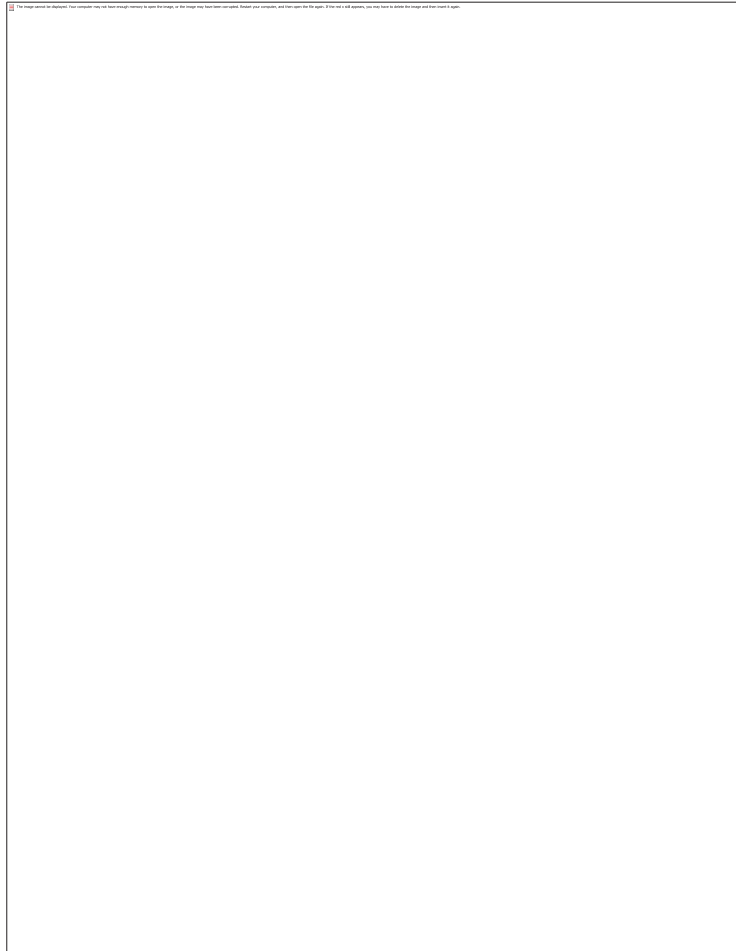


Global Water Vapor

May 30, 2010

1 Km Layer Precipitable Water RMS
% Differences from ECMWF
Data Assimilation QC

1 Km Layer Precipitable Water RMS
% Differences from ECMWF
Climate QC



— Version-6 DA (QC=0; PBest)
 — Version-6 Neural-Net (QC=0)
 — Version-6.1 DA (QC=0; PBest)
 — Version-6.1 Neural-Net (QC=0)

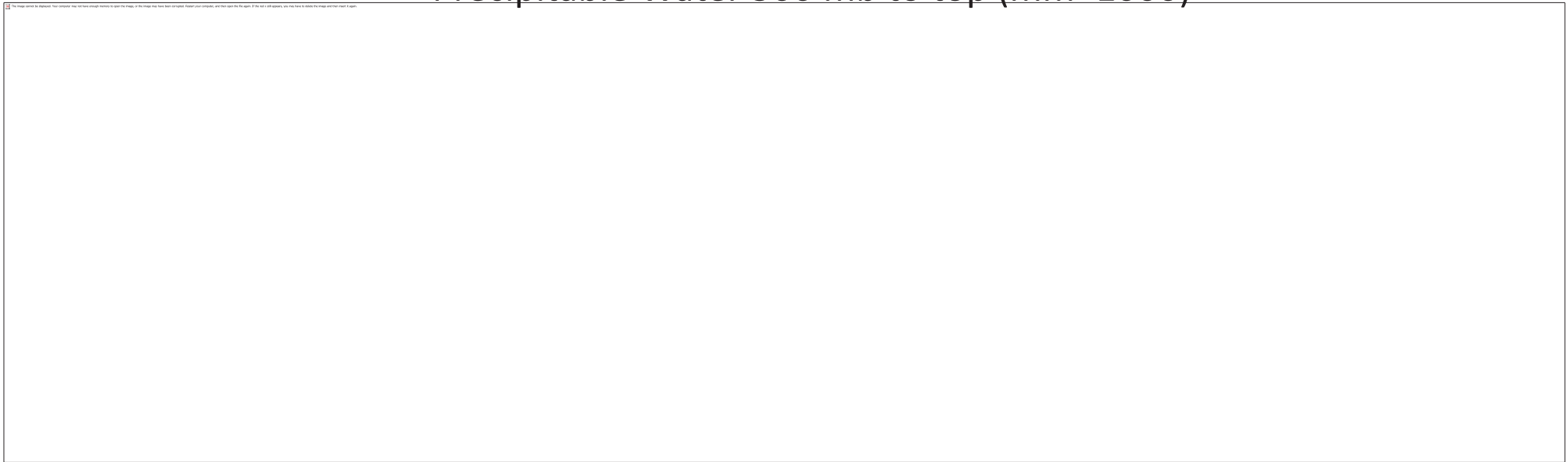
- - - Version-6 Climate (QC=0,1; PGood)
 - - - Version-6 Neural-Net (QC=0,1)
 - - - Version-6.1 Climate (QC=0,1; PGood)
 - - - Version-6.1 Neural-Net (QC=0,1)

Version-6.1 retrieval no longer degrades Neural-Net guess beneath 800 mb and improves Neural-Net guess above 800 mb with Climate QC

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May 30, 2010 1:30 PM
Precipitable Water 500 mb to top (mm*1000)



Global Mean = 11.21 STD= 12.37 %Filled= 87.22 Global Mean = 11.16 STD= 12.55 %Filled= 87.19

Precipitable Water 50 mb to top (mm*10000)



Global Mean = 1.55 STD= 0.03 %Filled= 87.35 Global Mean = 1.21 STD= 0.27 %Filled= 87.35

Version-6 erroneously contained tropospheric convection features in upper stratospheric water vapor field. This has been corrected in Version-6.1.

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More Short Range SRT Plans for Version-7

- Improve temperature profile retrieval by using tropospheric $15\ \mu\text{m}$ CO_2 channels that do not see clouds.

Theory says that $15\ \mu\text{m}$ CO_2 channels that see clouds should not be used in $T(p)$ retrieval. Version-6 assures this by using only stratospheric sounding CO_2 channels in $T(p)$ retrieval

Many tropospheric $15\ \mu\text{m}$ do not see clouds depending on the scene and can (should) be used in $T(p)$ retrieval for that case

- Evaluate the use of the difference in brightness temperature between 2 channels on and off weak CO_2 and H_2O lines as single pieces of information
- Improve $O_3(p)$ retrieval step
- Further refine error estimate and QC methodology
- Further stabilize cloud parameter retrievals

Some retrievals still do not converge



SRT Mid-Range Plans for Version-7: Higher Resolution (HR) Retrievals

Implement 1 (cross track) x 3 (along track) FOV retrieval system

This triples the spatial resolution and density of the AIRS soundings

Cloud clearing allows for up to two cloud formations in a 1x3 FOR

	<u>Nadir FOR</u>	<u>Largest Zenith Angle FOR</u>
Version-6	40.6 km x 40.6 km	115.0 km x 63.3 km
HR	13.5 km x 40.6 km	38.3 km x 65.3 km

Cloud clearing should improve, especially over land, because spatial variability of T_{skin} , ϵ_v , $q(p)$ is less in a smaller FOR

Retrievals should also improve, especially over land, because quantities to be retrieved vary less within a FOR

Boundary layer temperature and boundary layer water vapor should improve as well

SRT will investigate generation of 0.5 degree x 0.5 degree level-3 products using HR system



SRT Mid-Range SRT Plans for Version-7: Longwave Cloud Spectral Emissivity

Version-6 uses 57 channels to retrieve cloud parameters for each of two cloud layers $k=1,2$ for each AIRS Field of View (FOV)

$$\alpha\varepsilon_1, pc_1, \alpha\varepsilon_2, pc_2$$

where $\alpha\varepsilon_k$ is the product of a spectrally independent cloud emissivity and the geometric fractional cloud cover for a cloud at pressure pc_k as seen from above

We plan to determine a cloud spectral emissivity ratio $\alpha\varepsilon_\nu/\alpha\varepsilon^0$ for the upper level cloud in a form analogous to longwave surface spectral emissivity retrieval which uses 77 channels

This can be done one of two ways:

- Sequentially after current cloud retrieval step, using the current 77 surface longwave emissivity channels or
- Concurrently with cloud retrieval using 57 channels + 77 channels (134) channels

Cloud spectral emissivity will be used in spectral OLR calculation



Longer Term Plans

- 1) Include CO₂ retrieval as part of retrieval process
CO₂ retrieval is currently a post processing step
Does not interact with anything else

We plan to work with Ed Olsen to examine feasibility of:

- doing CO₂ retrieval after pass 1 and using retrieved CO₂ in recomputation of $T(p)$, OLR, everything else
- and possibly attempting coupled CO₂, $T(p)$ retrieval

Mous said this cannot be done – I am not so sure

- 2) Incorporating dust retrieval as part of retrieval process
 - Including dust score as part of error estimate procedure
This could help flag poor dusty retrievals
 - Including dust into the RTA used in second pass
This could potentially improve retrievals in dusty cases

